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(54) WIND POWERED GENERATING SYSTEM

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(57) Claim

1. A wind electric generating system comprising a wind rotor and a generator by which the electricity is generated at an alternating voltage substantially higher than that of the storage or required ultimate use voltage, means whereby the generated electricity can be transmitted at at least the generated voltage and subsequently, at the point of storage or adjacent the point of ultimate use, reduced to the required voltage.

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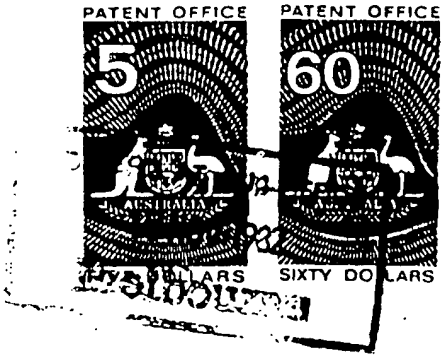

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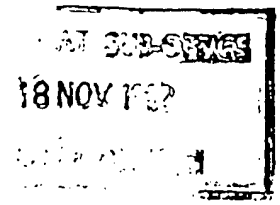

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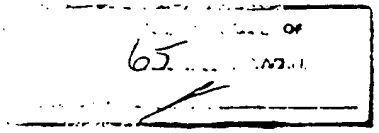
Complete Specification for the invention entitled:



WIND ELECTRIC SYSTEM

The following statement is a full description of this invention, including the best method of performing it known to me:—

This invention relates to wind electric systems and, in particular, to relatively small scale systems particularly suitable for domestic applications.

In certain areas wind electric systems have been used for many years and often they have comprised a blade which is rotated by prevailing winds which is directly or indirectly connected to a low voltage D.C. generator or an A.C. alternator and rectifier assembly, the output of which is fed to a bank of accumulators or the like which would normally be at 12, 24, 42, 48 or 110 volts.

Such systems have not been greatly efficient as there have been substantial heat losses in the windings of the generator or alternator due to the resistance of the windings and, further, the loss increases greatly as the power output increases, that is with increasing wind velocity.

Also, such arrangements were inefficient if the generator was to be located any substantial distance from the accumulators, as there were substantial transmission line losses.

The principal object of the present invention is to provide a wind electric system which is more efficient than those previously proposed and a secondary object is to provide, in combination with such an improved system, an improved pumping system.

The invention in its broadest sense comprises a wind electric generating system comprising a wind rotor and a generator by which the electricity is generated at an alternating voltage substantially higher than that of the storage or required ultimate use voltage, means whereby the generated electricity can be transmitted at at least the generated voltage, and

subsequently, at the point of storage or adjacent the point of ultimate use, reduced to the required voltage.

In one particular aspect of the invention I prefer to use a three phase permanent magnet alternator which feeds a load which has a capacitive component to enable matching of the output to the load over a range of speeds of rotation of the rotor.

Another object of the invention is to provide means whereby the output of a three phase alternator can be switched from star to delta configuration depending upon the wind speed and, thus, the speed of rotation of the wind rotor.

A still further feature of the invention is to provide a permanent magnet alternator in which the pole pieces of the armature are eliptical and/or helical thus reducing the initial magnetic drag.

In a still further feature of the invention I provide a wind rotor having variable pitch blades to enable rotation to commence at wind speeds less than those needed for a blade having the required pitch for running and which permit the maximum utilisation of wind energy when the rotor is spinning.

A still further feature of the invention is to provide, in association with the output of the generator, silicon controlled rectifiers to provide the optimum loading on the wind rotor at any wind speed.

The invention also relates to the provision of an improved wind powered water pumping system in which the pump is an electrically operated pump located at the optimum location to maximise pump efficiency and the

power is supplied from a wind powered electric system, as described herein, which is located at a position to obtain maximum benefit from prevailing winds.

It will be seen that such an arrangement is substantially more efficient than pumping systems using a pump driven directly mechanically by a wind rotor or the like as, in such systems, a compromise has normally to be reached as to the siting of the wind pump so that the rotor and the pump can each operate with reasonable efficiency.

In order that the invention may be more readily understood, I will describe one particular form of wind electric system made in accordance with my invention, together with certain modifications which can be used individually or in combination in the operation of the system.

In the broad concept of the invention I provide a wind rotor in the form of a wind rotor which may be of any type which can satisfactorily convert wind energy into rotational energy and is preferably of a relatively high speed form.

Alternatively, a low speed rotor can be used if associated with a gear box whereby a relatively high speed output can be obtained. A gear box to provide high generator or alternator speeds can also be used with a high speed rotor.

Associated either directly or through the gear box with the rotor there is a high voltage alternator. By the term high voltage I mean a voltage which is high relative to the required end use voltage or to voltages normally used in domestic wind generating systems.

Preferably I use a three phase alternating current alternator, and this will be assumed herein, but the invention is not restricted to such use. One satisfactory form of alternator is a 415 volt A.C. alternator.

I have found that, by using such an alternator system, generation efficiency is greater than has been the case using low voltage generators or alternators because heat losses in the windings are minimised.

I prefer that the electricity generated be transmitted to end use storage or use by transmission lines at at least the generated voltage.

It will be appreciated that the power losses in transmission are less for high voltage A.C. than they are for lower voltage A.C. and for D.C. power. This is particularly true when low cost (low copper content) transmission lines are used.

Normally the power generated by the system of the invention would be used to maintain the charge in an accumulator bank and, at the use site, would pass through a transformer and rectifier system to enable the charging of an accumulator bank to, say, 12, 24, 32, 48 or 110 volts.

It will thus be seen that not only is the generation of power using the method of the invention more efficient than has previously been achievable but, also, I also obtain benefits in the transmission of the power to its end use position.

It may well be preferred in the invention to use three phase permanent magnet alternators. These, whilst efficient when run at optimum speed, tend to have inefficiencies away from this speed when the unit is feeding a load which is substantially purely electrically resistive, that is a typical

load. For this reason I have found that satisfactory operation over a considerable range of input powers can be achieved if the load, instead of being resistive, includes a capacitive component, that is that the current in the load leads the voltage. Use of such a load permits design whereby the output of the permanent magnet alternator can be more successfully matched to the load over a wide range of speeds of rotation to thus make the system efficient in a wide range of wind speeds.

In order to increase the efficient range of operation I can also provide a means whereby the alternator or transformer windings can operate in either star or delta configurations to thus provide an output which is more satisfactory depending upon the wind speed. This can be achieved by sensing the frequency of the output which is directly dependant on the shaft speed and to change the winding configuration in the alternator or transformer configurations to provide the optimum loading of the wind rotor for a particular shaft speed.

In another aspect of the invention I have found it desirable to modify a conventional permanent magnet alternator to provide efficient operation in association with the system of the invention.

In conventional alternators the pole pieces of the armature are usually each in the form of an arc of a circle and, when the alternator, is stopped these tend to assume a position relative to the field stator windings in which the magnetic attraction is the maximum. This means that the initial torque to commence the armature rotating is high, as it is initially essential to break this attraction. This problem is not great once the armature is spinning as, in this case, the retarding forces acting on the armature are largely dependant upon the load as the momentum of the system overcomes the

difficulties caused by field orientation.

I have found that I can minimise this difficulty in either of or a combination of two ways.

In the first, by forming the pole pieces of the altenator to be eliptical rather than arcuate there is a reduction in the initial torque necessary to cause the alternator to rotate and, in turn, this means that the wind rotor will rotate in winds which would not otherwise be sufficient to initiate rotation.

In the second, I form the pole pieces to be located in a helix. That is there is no break in the magnetic fields parallel to the axis of the rotor and no orientation where the magnetic attraction is substantially higher than any other.

In each of these arrangements the efficiency of the system is increased as the rotor starts to rotate at a wind speed less than is possible in conventional arrangements.

In systems of the general type of the invention it has been found that the most efficient wind rotor is one of a high tip speed ratio type. In these the desirable tip speed ratio is greater than 4:1, that is the tip of the blade travels at a speed greater than four times the speed of the wind that drives it. Again, as with the previous difficulty, there is a necessity for substantial torque to cause the rotor to commence rotation as, aerodynamically, it is stalled and it has to overcome friction and also, any electrical or magnetic resistance in the alternator.

In order to overcome this difficulty I use blades having variable pitch which

is controlled by the hub whereby, when the rotor is stationary, the blade adopts an angle of incidence which permits maximum benefit being obtained from low winds to commence rotation, at which time the pitch is changed to enable it to operate in the high tip speed ratio mode.

The control of the hub can be mechanical, hydraulic or electrical.

I mentioned earlier that the wind electric system of the invention can be applied in various applications where a wind rotor would normally directly mechanically drive the operative member. The obvious and most usual application would be in pumping systems but could also be in mills which are directly driven by wind.

In these circumstances, the operation is divided so that a wind electric system is located at an optimum position and the other component of the system, say a pump, is located at its optimum position but is electrically driven by the power generated by the wind electric system which is passed along high voltage transmission lines to the pump, which may operate either directly at the high voltage or may have associated therewith a transformer and/or rectifier to provide the power required.

Particularly as far as pumps are concerned, where it is desirable that the pump be located at or below the water level, the siting of a direct mechanical wind pump may be most unsatisfactory.

Also, such an arrangement gives a great deal of flexibility, particularly for temporary installations, and may permit the use of any excess electrical power generated for other applications.

The claims defining the invention are as follows:-

1. A wind electric generating system comprising a wind rotor and a generator by which the electricity is generated at an alternating voltage substantially higher than that of the storage or required ultimate use voltage, means whereby the generated electricity can be transmitted at at least the generated voltage and subsequently, at the point of storage or adjacent the point of ultimate use, reduced to the required voltage.

2. A system as claimed in claim 1 wherein the generator is an alternator.

3. A system as claimed in claim 2 wherein the alternator is a three phase alternator.

4. A system as claimed in claim 2 or claim 3 wherein the alternator is a permanent magnet alternator.

5. A system as claimed in claim 4 wherein the pole pieces of the alternator are either eliptical or helical in form to reduce the initial torque necessary to cause the alternator to rotate.

6. A system as claimed in any one of claims 3 to 5 wherein the alternator output can be switched from star to delta configuration, depending on the speed of rotation of the alternator.

7. A system as claimed in any one of claims 3 to 6 wherein the system

load has a capacitive component to effect better matching of the alternator input to the output of the wind rotor over a range of speeds of rotation of the alternator.

8. A system as claimed in any preceding claim in which there is a gear box between the wind rotor and the alternator whereby the alternator operates at a speed greater than the speed of rotation of the wind rotor.

9. A system as claimed in any preceding claim wherein the blades of the wind rotor have a variable pitch to permit efficient operation over a range of wind speeds.

10. A pumping system comprising a wind electric generating system as claimed in any preceding claim, the wind rotor and generator or alternator being located at an optimum position to receive wind effect and a pump located at an optimum position relative to a water source and a transmission line connected between the generator and the pump and means at the pump whereby the electricity generated can be matched to that required to operate the pump.

11. A wind electric generating system substantially as hereinbefore described.

12. A pumping system substantially as hereinbefore described.

DATED this 18th day of November, 1982

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By his Patent Attorneys

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